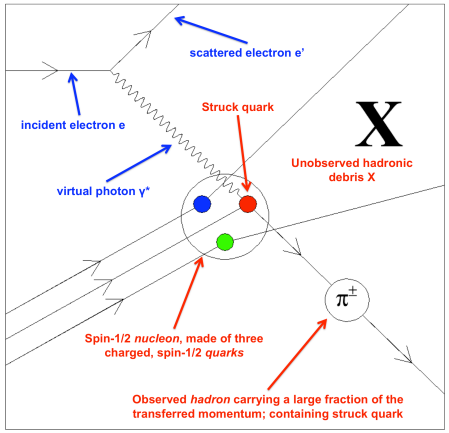
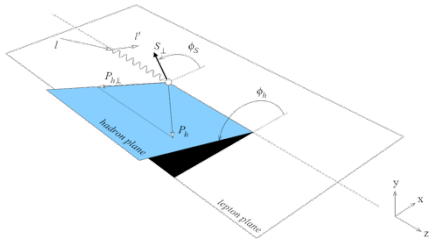
Introduction

Semi-Inclusive Deep Inelastic Scattering: Probing the Quark Structure of the Nucleon



- Study nucleon transverse spin and momentum structure through SIDIS
- Considering all possible orientations of beam and target polarization, we have eight independent amplitudes at leading twist:



$$\frac{d\sigma}{dx dy d\phi_S dz d\phi_h dP_{h\perp}^2} = \frac{\alpha^2}{xyQ^2}\frac{y^2}{2(1-\varepsilon)}\cdot$$

$$\{F_{UU,T} + \ldots$$
$$+ \varepsilon\cos(2\phi_h)\cdot F_{UU}^{\cos(2\phi_h)} + \ldots$$
$$+ S_L[\varepsilon\sin(2\phi_h)\cdot F_{UL}^{\sin(2\phi_h)} + \ldots]$$
$$+ S_T[\sin(\phi_h+\phi_S)\cdot F_{UT}^{\sin(\phi_h+\phi_S)}$$ Collins effect
$$+ \sin(\phi_h-\phi_S)\cdot(F_{UL}^{\sin(\phi_h-\phi_S)} + \ldots)$$ Sivers effect
$$+ \varepsilon\sin(3\phi_h-\phi_S)\cdot F_{UT}^{\sin(3\phi_h-\phi_S)} + \ldots] + S_L\lambda_e[\sqrt{1-\varepsilon^2}\cdot F_{LL} + \ldots]$$ Pretzelosity
$$+ S_T\lambda_e[\sqrt{1-\varepsilon^2}\cos(\phi_h-\phi_S)\cdot F_{LT}^{\cos(\phi_h-\phi_S)} + \ldots]\}$$

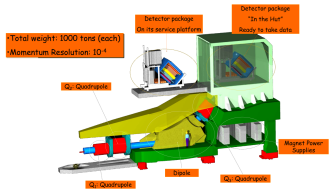
f_1 =
$h_1^\perp$ =
$h_{1L}^\perp$ =
h_1 =
$f_{1T}^\perp$ =
$h_{1T}^\perp$ =
g_1 =
g_{1T} =

Conventions

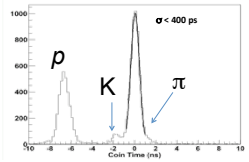
- Nucleon with transverse or longitudinal spin
- Parton with transverse or longitudinal spin
- Parton Transverse momentum

Asymmetry $\Longrightarrow$ $A_{UT}(\phi_h^l, \phi_S^l) = \frac{1}{P}\frac{N^\uparrow - N^\downarrow}{N^\uparrow + N^\downarrow}$

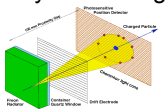
JLab E06-010: Neutron Transversity

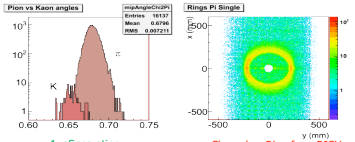


High Resolution Spectrometer



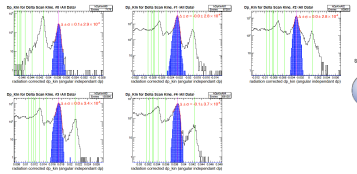
PID by time-of-flight

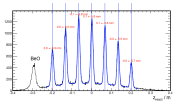




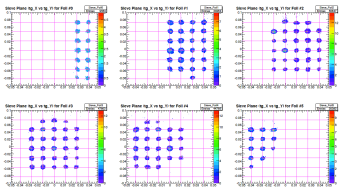
4 σ Separation — Cherenkov Ring from RICH

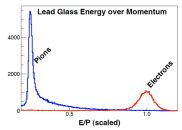
PID using RICH



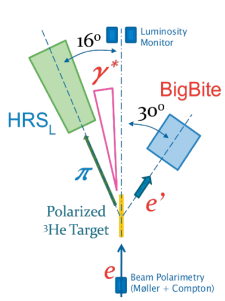


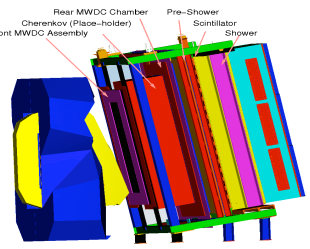
·Optics:
- Momentum (above)
- Vertex (left)
- Angles/sieve slit reconstruction (below)



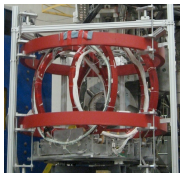


Electron-pion separation using Gas+Aerogel Cerenkov, and preshower+shower calorimeter

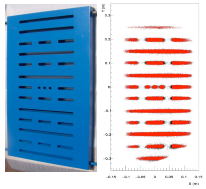




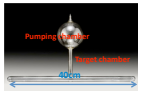
BigBite Spectrometer



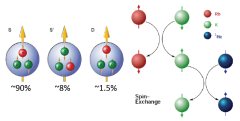
Polarized ^{3}He Target



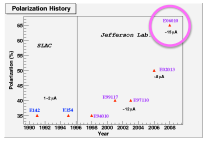
Sieve Pattern/Angle Reconstruction



- Rb-K spin-exchange hybrid cell at 10 atm.
- ~65% in-beam target polarization with spin-flip every 20 minutes: ***WORLD RECORD***
- NMR and EPR Polarimetry
- New narrow band **COMET lasers**

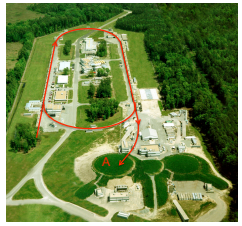


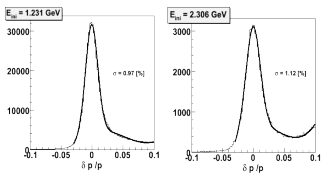
^{3}He as effective polarized neutron target



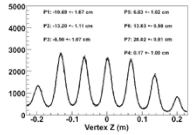
World Record in-beam Polarization

Jefferson Lab

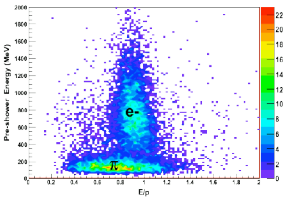




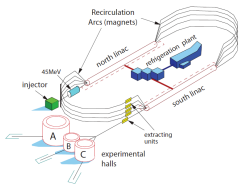
Momentum Reconstruction



Vertex Reconstruction



Electron ID using shower + preshower



Project Status

- LANL-led collaboration:
  - X. Jiang (co-spokesperson)
  - A. Puckett (data analysis and simulations)
  - L. Guo (Run Coordinator)
- Over 115 physicists from over 30 international institutions

Jefferson Lab E06-010 Collaboration

Institutions

CMU, Cal-State LA, Duke, Florida International, Hampton, UIUC, JLab, Kharkov, Kentucky, Kent State, Kyungpook National South Korea, LANL, Lanzhou Univ. China, Longwood Univ. Umass, Mississippi State, MIT, UNH, ODU, Rutgers, Syracuse, Temple, UVa, William & Mary, Univ. Sciences & Tech China, Inst. of Atomic Energy China, Seoul National South Korea, Glasgow, INFN Roma and Univ. Bari Italy, Univ. Blaise Pascal France, Univ. of Ljubljana Slovenia, Yerevan Physics Institute Armenia.

Collaboration members

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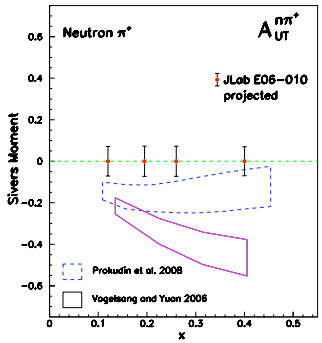

Projected Uncertainties, Neutron π^+ Sivers Moments

- First target SSA measurements in the SIDIS reaction ^{3}He(e,e'$\pi^\pm$)X on a transversely polarized "neutron" target
- Existing data:
  - Proton Collins+Sivers: HERMES Collaboration, PRL 94, 012002 (2005); PRL 103, 152002 (2009)
  - Deuteron Collins+Sivers: COMPASS Collaboration, 94, 202002 (2005)
- Measure angular modulation of the asymmetry by rotating target spin (±vertical, ±transverse); extract Collins, Sivers moments